Journal of the Royal Society of Western Australia, Vol. 67, Part 2, 1985, p. 45-57.

The flora and vegetation of Mt Lesueur, Western Australia

by E. A. Griffin[1] and A. J. M. Hopkins[2]
47 McMillan Street, Victoria Park, Western Australia, 6100
[2] Western Australian Wildlife Research Centre, P.O. Box 51, Wanneroo, Western Australia, 6065
Manuscript received 22 November 1983; accepted 21 August 1984.

Abstract

This paper details the results of a comprehensive survey of Mt. Lesueur, an important botanical locality in south-western Australia. Both the laterite cap of the mesa and the steep slopes support the complex kwongan (sclerophyllous shrub) vegetation which typifies much of this region. The total of 287 vascular plant species encountered in an area of less than 0.5 km^2 suggests exceptional richness for this site. Almost 25% of species were either rare, had restricted distributions, or were at the northern limits of generally more mesic distributions. Some of these species were only found in the most favourable sites on the hill. These patterns suggest a refugial role for Mt. Lesueur and may imply a particular sequence of climatic events during the Holocene. A number of species which frequently occur on lateritic uplands in the region were either absent from, or rare on, the top of Mt. Lesueur. One possible explanation for these anomalous distributions is that the habitat already has a stable complement of species.

Introduction

Mt. Lesueur, a laterite capped mesa situated in a deeply dissected part of the northern kwongan or sandplain region of Western Australia, has long been considered a site of special botanical significance. It has been recognised as being central to a node of high angiosperm species richness, particularly of the Proteaceae (Speck 1958, George *et al.* 1979) and as having populations of a number of rare or geographically-restricted species (Gardner 1947, CTRC 1975). Further, the hill and nearby areas are thought to support northern outlying populations of species with more generally southern distributions (CTRC 1975).

The first collection of plants from Mt. Lesueur was made by James Drummond in *c.* 1851. His glowing reports of the area and mention of new, unusual species from there encouraged C. A. Gardner to attempt, during the period 1931-1946, to retrace Drummond's steps, and to recollect the species. This he accomplished with some success. Gardner also discovered two new species on Mt. Lesueur and subsequently published a note extolling the botanical values of the area (Gardner 1947). The vegetation was first described in detail by Speck (1958) who also enumerated 88 species for the hill top. The area has received little detailed botanical attention since that time: the recommendations for the inclusion of Mt. Lesueur in a conservation reserve (CTRC 1975) were justified on the basis of existing lore. The implementation of these recommendations was delayed because some major land-use conflicts were subsequently identified. It seemed appropriate, therefore, to further document the botanical features of the area to assist with resolution of these conflicts.

In addition to describing the flora and vegetation of the hill itself, we have attempted to provide a context for these results through the study of much of the surrounding area. The particular combination of topographic and geological features around Mt. Lesueur has, in fact, provided a unique opportunity for the study of an array of features of complex kwongan vegetation. The results of these studies will be detailed in a series of publications. This first paper provides an account of the flora and vegetation of the plateau top and the slopes of Mt. Lesueur. Subsequent papers will report on matters such as regional variation in floristic composition, patterns of diversity, and influence of soils, geology and aspect on floristic patterns.

The Study Area

Mt. Lesueur (30°11'S, 115°12'E) is about 22 km NE of Jurien and about 115 km N of Perth (Fig. 1). It is within a small reserve for Educational Purposes (Class C Reserve No. 24275) which is itself set within a larger reserve for Horse Breeding (C 15018). The whole area supports indigenous vegetation; limited horse-grazing in the past has apparently exerted a relatively minor influence.

Physiography and Soils

In the setting of the generally subdued topography which characterises much of south-western Australia, Mt Lesueur is a prominent landscape feature. It was named by the early French navigator Hamelin as he sailed up the coast in 1801 and now has a trigonometric station (313 m) near its southern edge. However, it barely exceeds the height of the surrounding uplands; its visual prominence is largely attributable to its mesa form which has resulted from the dissection of a near-horizontal Tertiary landscape and its separation from the surrounding uplands by valleys over 100 m deep.

The study area is in the northern part of the Perth Sedimentary Basis. The N-S trending Lesueur Fault on the eastern slopes of Mt Lesueur separates the Triassic Lesueur Sandstone(in the west) from the Jurassic Cockleshell Gully. Formation (sandstone, siltstone and shale) (in the east) (Lowry 1974, Playford *et al.* 1979). Deflation during the period of tectonic stability which followed the lower Crestaceous phase of block faulting permitted the development of a gently undulating landscape. A lateritic soil profile developed from the mid-Tertiary onwards. This landscape was dissected by a series of E-W drainage lines which have subsequently been disrupted (interpreted from unpublished maps, W.A. Dept. of Lands and

38442 (1)

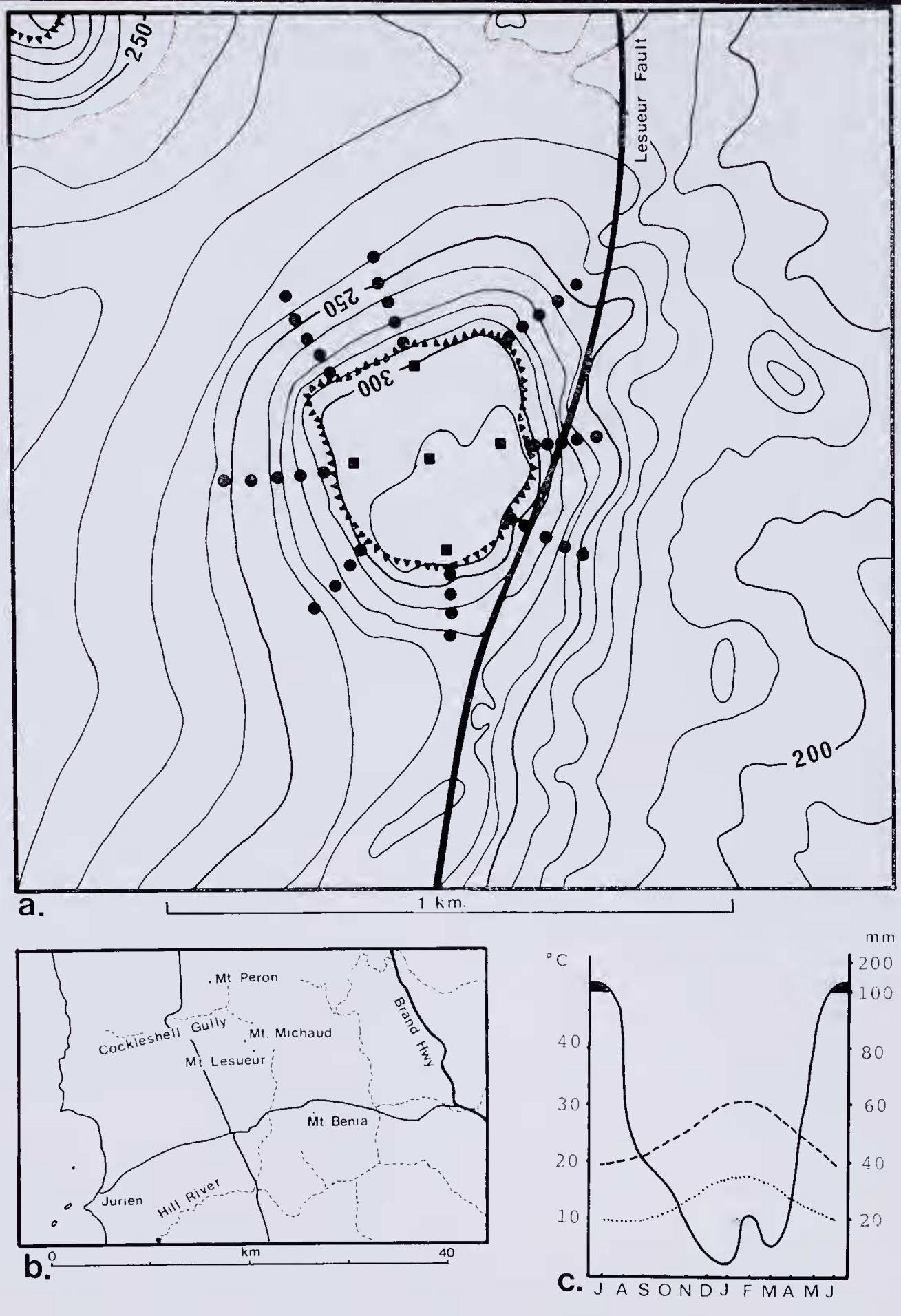

Figure 1.—Physical features of the study area:
a) topographic map compiled from W.A. Department of Lands and Surveys unpublished maps showing sample quadrats (■) and slope relevés (•) and the Lesueur Fault. The approximate limits of the plateau are also indicated;
b) location map of Mt Lesueur in relation to the town of Jurien (*c.* 200 km N of Perth) and major roads, drainage lines and other hills; and
c) ombrothermic diagram for Jurien (unpublished data for 1968-1981 from the Bureau of Meteorology).

Surveys). Marine incursions during the Pleistocene involving a maximum relative increase in sea level of about 100 m (Lissiman and Oxenford 1973) have not directly influenced that area of this study.

Present soil patterns generally reflect the landscape stability and general aridity of the period during and since the Pleistocene, which relatively localised deposition of erosional products derived from the old, deep, lateritic soil profile. However, no detailed soil mapping or pedogenetic studies have been conducted in the study area. The following description of Mt Lesueur is based on our own observations and some generalizatons extrapolated from a site *c.* 50 km to the south east which has been described by Churchward (1970).

The plateau top of Mt Lesueur is a *c. 10 ha* remnant of the upper part of the lateritic soil profile developed from the Lesueur Sandstone. The typical, massive, duricrust (cemented laterite) which covers most of the top is the result of exposure and subsequent hardening of a ferruginous B soil horizon after removal of the sandy A horizon. Minor subsidence of the duricrust layer is suggested by its roughened and broken nature. Only a few, small, shallow pockets of grey sand are present although this sand is also in cracks in the duricrust. In some areas the sand has a well developed organic layer. What little gravel is present appears to be mainly angular fragments of duricrust rather than discrete pisolites.

At the margins of the plateau, the duricrust is generally broken into large boulders of up to 0.5-1 m diameter. Very little sand occurs. On the north-eastern part of the rim there is a small quantity of coarse, pisolitic gravel.

The slopes of Mt Lesueur are steep ranging from about 30° close to the plateau to about 5° at the foot of the hill, with most of the mid-slope region being in the order of 20°. The duricrust rim provides an occasional vertical drop of up to 3 m. At the foot of the southern, western and northern slopes there is an accumulation of erosional material. The eastern slopes are generally more steep (to 45° in the upper slope) perhaps reflecting the proximity of the Lesueur fault.

The soils generally reflect the steepness and probably the relative stability of the slopes. There is little soil present on the upper portions of the eastern slopes: these surfaces are mainly weathered Lesueur Sandstone which is pale grey, coarse grained and highly siliceous. The southern, western and northern slopes have shallow soils composed of grey sand and gravel with some clay material present. The gravel is most abundant on the mid slopes whereas sand predominates at the foot. Duricrust boulders up to 1 m in diameter litter the upper third of the slopes. Generally the southern and western slopes have more duricrust boulders than the northern slopes where pisolitic gravel is more abundant. As a consequence of this, the northern slopes have a smother surface than those of the southern and western aspects.

The Lesueur fault is evidenced about half way down the eastern slope by outcroppings of a ferruginous, partially metamorphosed sandstone accompanied by changes in soil type. Small near-vertical cliffs up to 3 m high occur along the faultline and boulders up to 20 m diameter are also present immediately downslope from it. Shallow grey sands and gravel occur on the steeper slopes above the fault zone, whereas below it there are deeper, red-brown sandy-clay soils often with substantial amounts of gravel.

Climate

No detailed climatic information is available for the immediate vicinity of Mt Lesueur: the closest weather station is at Jurien (14 years records). The area experiences a Thermomediterranean accentuated climate (UNESCO—FAO 1963) with interpolated values of average annual rainfall, mean summer temperature and potential evaporation (from Bureau of Meteorology 1968) being 625 mm, 23°C and 1770 mm respectively. The ombrotherimic diagram for Jurien is given in Fig. 2. Winds in mid-summer are predominantly dry and easterly with some afternoon sea breezes (from the SW) where as mid-winter winds are moisture bearing and westerly (N-SW). Estimates of solar radiation for 20° slopes at the latitude of Mt Lesueur show that N-facing slopes receive approximately twice that of S-facing slopes in mid winter but values for mid-summer differ only slightly (G. Roy pers. comm. 1982, see also Roy and Miller 1980). Other effects of landscape on local climate patterns are unknown.

Fire history

The last known fire around Mt Lesueur occurred in March 1967 (J. Grigson pers. comm. 1982). There is no obvious indication on the 1969 aerial photos that this fire missed our study area although there may be remnants of older vegetation in the valleys to the east of Mt Lesueur. The two extensive fires in areas of native vegetation to the NE and NW of Mt Lesueur in early 1983 were both brought under control outside our study area. The major wildfire of January 1984 was confined to the coastal areas of the proposed nature reserve.

Previous descriptions of the vegetation

In his early delineation of vegetation and phytogeographic units in the west-coastal of the South-West Botanical Province, Speck (1958) included Mt Lesueur within his Lesueur Vegetation System, a sub-unit of his Lesueur Botanical District. He described the vegetation as lateritic heath on the lateritic plateau area; sandplain heath, mallee heath and sandplain scrub heath on the sandy lateritic soils of the hill slopes; and low scrub forest and woodlands on the deeper sands, clays and clay loams in the valley bottoms. These vegetation and phytogeographic units were subsequently revised by Beard (1979, 1980) who took two hilly areas (the Gairdner Range, including Mt Lesueur, and the Herschel Range) out of the Lesueur System and placed them in a separate unit, the Gairdner Vegetation System. This distinction was based on the importance of eucalypt woodlands in the valleys of these hilly areas; the uplands of Beard's (1979) Gairdner and Lesueur Systems both support similar heath and scrub-heath vegetation. These two Vegetation Systems represent the southern-most part of the Irwin Botanical District as redefined by Beard (1980).

Methods

Detailed sampling of the Mt Lesueur-Cockleshell Gully area was conducted between July and November 1979. This involved sampling the vegetation on numerous lateritic upland areas, as well as some pediment slopes below escarpments (breakaways) and the recent, rejuvenated valleys. Although this paper only presents results from the Mt Lesueur sites, sampling techniques consistent with those outlined in detail here have been used throughout.

Five 10 m x 10 m quadrats were located on the top of Mt Lesueur: one in the approximate centre of the plateau and one each to the north, east, south and west near to the edge. These four cardinal quadrats were centred a minimum of 20 m from the plateau edge to avoid some obvious effects of the edges on species composition. Cover-abundance values (Domin Krajina scale, Mueller-Dombois and Ellenberg 1974, p. 62) were recorded for each vascular plant species present in each quadrat. The remainder of the plateau was searched thoroughly for species other than those found in the quadrats. Species found only on the rim (within 5 m of the edge of the plateau) were noted separately.

The slopes were sampled along 8 transects running N, NE, E, SE, S, SW, W and NW from the approximate centre of the plateau (Fig. 1). Use of quadrats was impracticable on the steep slopes so we recorded species present in subjectively defined relevés of about 200 m^2, centred at 50 m intervals from the rim down the slope, commencing 15 m below the rim. A total of 38 relevés were sampled: 5 along each transect except those of the S and SW slopes where the deep, valley sands were encountered after 4 relevés.

Studies of species-area relationships in kwongan vegetation (George *et al.* 1979) and specifically at this site (our unpublished data) indicated that the difference in species richness due to differences in areas between the quadrats and the relevés is of the order of 3-5% of the total species present at a site Thus for the purposes of this study we consider these plateau quadrat and slope relevé samples to be comparable.

Observations on soils were recorded at all sites: these have provided the basis for the comprehensive site description already given. Also noted were vegetation structure (according to Specht in Aplin 1979), percentage bare ground and growth habits of species.

Plant specimens were determined at the Western Australian Herbarium (PERTH) where voucher specimens labelled "EAG Latrite Survey 1978/79" are now lodged. Unnamed species are referred to in the text by collector and collection number (e.g. EAG 2575). Aerial photographs from the W.A. Department of Lands and Surveys (1969) were examined for soils—vegetation unit interpretation as well as for the fire history details already given.

In order to compare our list of species with that of Speck (1958), it was necessary to refer back to Speck's original specimens. A thorough search was made of collections in the herbarium of the Botany Department, University of Western Australia. Where original specimens could be located, these were redetermined in the light of present day taxonomic knowledge. For names used by Speck but not represented by a specimen, appropriate species' distributions were checked at the Western Australian Herbarium. If it was found that Mt Lesueur was within the known distribution of a species reported by Speck (1958), then that species name was accepted. If Mt Lesueur could not be considered to reasonably fit the known distribution of a species reported, even acknowledging the possibility of a disjunction, then a species known to occur in the area with which it might have been confused was proposed.

Results

Floristics.

A total of 287 vascular plant species were found on Mt. Lesueur; these are listed with summaries of occurrence in Appendix I. These species represented 43 families and 131 genera and included 3 indeterminate species and 20 apparently undescribed taxa. Seventy-eight genera and 15 families were represented by only one species each. The four families with the greatest numbers of species recorded, Proteaceae (46 spp.), Leguminosae (39 spp.), Myrtaceae (33 spp.) and Liliaceae (20 spp.) together accounted for almost half the species. Nine genera had 6 or more species present: *Hakea* (15), *Acacia* (12), *Stylidium* (10), *Eucalyptus* (9), *Daviesia* (7), *Hibbertia* (7), *Conostylis* (6), *Petrophile* and *Thysanotus* (6).

The distribution of these plant species was not uniform over the mesa: 14 species were found only on the plateau top well away from the rim, 14 were confined to the rim and 123 species were confined to the slopes (Table 1). Thus there were clear floristic differences between the plateau top and the slopes and this will be developed in a subsequent paper. The rim appeared to be a transition zone between the two habitats but had greater floristic affinities with the slopes than with the remaining plateau area. It was common for species that were abundant on the slopes to have a

Table 1.

Numbers of species occurring on and around Mt Lesueur.

Locality	No.	% of Total
Total species on Mt Lesueur	287	100
Species recorded on plateau* quadrats	109	38·1
Species occurring on plateau top	137	47·7
Species only on plateau top	14	5·0
Species occurring on hill slopes plus rim	273	95·1
Species only on hill slopes plus rim	150	52·6
Species only on hill slopes	123	43·0
Species only on rim	14	5·0
Species in common with other lateritic uplands of the region†	242	84·6
Species in common with other lateritic uplands but not on plateau top (i.e. only on slopes and rim)	109	38·1

* rim excluded from the plateau top.
† Griffin and Hopkins unpublished data.

few individuals on the rim. Structurally, however, the vegetation of the rim differed little from the plateau top, with much of the area being dominated by *Dryandra sessilis*.

Reeonciliation with earlier eollections.

N. H. Speck (1948) had previously listed 88 plant species for the top of Mt. Lesueur. We investigated this collection in detail; the results are detailed in Appendix II, copies of which are lodged with the Editor and the Librarian, Western Australian Herbarium. In summary, we consider that 23 of Speck's names are now incorrect and we have provided alternatives. Sixty of the 86 species were also found by us to occur on the plateau top. A further two of the species were found on the rim. We recorded 12 more on the slopes. We did not locate specimens of the remaining 12 species on Mt. Lesueur. In fact, for three of the species, *Conospermum densiflorum, Dryandra earlinoides* and *Grevillea rudis,* we have not found populations within 2 km of Mt. Lesueur, despite extensive searches. For a further three species *(Conospermum erassinervium, Daviesia quadrilatera* and *Leehenaultia hirsuta)* we have not found any populations associated with lateritic soils in the Mt. Lesueur-Cockleshell Gully area.

Rare and geographically restrieted speeies.

Nine species occurring on Mt Lesueur have been reported as being rare (Table 2). Three of these *(Banksia tricuspis, Hakea megalosperma* and *Uroearpus phebalioides)* have been gazetted rare under the provisions of the Wildlife Conservation Act 1950-1979 (Rye and Hopper 1981).

Table 2.

Geographically restricted and rare species (presently named species only) found on Mr Lesueur. Data are from (1) CTRC 1975, (2) Griffin (unpublished data), (3) Marchant and Keighery (1979), (4) Rye (1982) and (5) Rye and Hopper (1981).

Species	Geographic Range (km) (1, 4)	Species reported as being rare and source of classification
Acacia epacantha	<150	
Acacia retrorsa	<50	2, 3
Banksia grossa	<150	
Banksia micrantha	<150	
Banksia tricuspis	<50	1, 2, 3, 5
Casuarina grevilleoides	<150	
Comesperma acerosum	<150	
Conospermum nervosum	<150	
Conostylis crassinervia	<150	
Darwinia helichrysoides	<50	1
Darwinia neildiana	<150	
Darwinia sanguinea	<150	
Dryandra sclerophylla	<150	
Gasrolobium bidens	<150	
Hakeeaflabellifolia	<150	
ucoantmegalosperma	<50	1, 2, 3, 5
Upkraneurophylla	<50	1, 2
hkapsogon plumuliflorus	<50	1
Petrochile chrysantha	<150	
Perroohile inconspicua	<150	
Tetratheca remota*	<50	2
Urocarpvs phebalioides	<50	2, 5
Xanthosia tomentosa	<50	1

* Species reported for Mt Lesueur by Thompson (1976) but not found in the present study.

Twenty-three of the species found on Mt Lesueur have known population ranges of less than 150 km; of these, all 9 species already listed as rare have known ranges of < 50 km (Table 2) (Griffin, unpublished data). In addition, most of the 20 undescribed species (see Appendix I) are probably geographically restricted.

None of the restricted or rare species occurs only on Mt Lesueur. *Banksia tricuspis* occurs on the top and slopes of Mt Lesueur and other hills in the Gairdner Range. *Hakea megalosperma* occurs on the top of some lateritic uplands near and including Mt Lesueur. *Hakea neurophylla* is mainly on some of the breakaway slopes in the Mt Lesueur—Cockleshell Gully area. *Urocarpus phebalioides* is known only a few breakaway slopes in the same area. *Tetratheea remota* is known from the Type specimen from Mt Lesueur, three other collections by Drummond for which no precise localities were given (Thompson 1976) and one more recent collection from just east of Mt Lesueur (R. J. Hnatiuk pers. comm. 1982). *Acacia retrorsa* occurs on some slopes and clap soils of the Cockleshell Gully area.

The 23 restricted, named species include both recently derived species (with close relatives nearby, e.g. *Acaeia epacantha, Banksia grossa, B. micrantha, Darwinia helielirysoides, D. neildiana, Hakea auri-eulata* var. *spathulata, Petrophile ehrysantha, Stylidium pyenostaehyum)* and species which may be described as probably relictual, having no close taxonomic relatives in the area (e.g. *Darwinia sanguinea, Hakea marginata, H. megalosperma, H. neurophylla Isopogon sphaerocephalus, I. linearis)* (G. J. Keighery, B. B. Lamont, B. R. Maslin pers. comm. 1982, Hopper 1983). There are no restricted monospecific genera on Mt Lesueur. Of the 20 undescribed species, all but one belong to genera represented by other species on Mt Lesueur.

Species with outlying populations

Twenty-six of the species found in this survey have distributions for which Mt Lesueur represents an outlying or extreme northern occurrence (Table 3). *Aeacia teretifolia, Billardiera coeruleo-punctata, Boronia crassifolia, Isopogon sphaeroeephalus, Stylidium carnosum* and *Thysanotus anceps* are examples of species with their main populations no closer than 150 km to the south. Species at the northern limits of more continuous distributions include *Anartlria graeilis, Chorizema ilicifolium, Euealyptus ealophylla, E. marginata, Isopogon asper, Kingia australis, Patersonia serieea* var *rudis* and *Trymalium floribundum*. Some of these continuously distributed species may actually have disjunctions near their range limits which are not revealed by the sparse herbarium data. *Eucalyptus marginata,* for example, has a probable gap in its distribution of *e.* 120 km between Mt Lesueur and the next population to the south (Lange 1960, Churchill 1968, Hopkins *et al.* 1983). This species in confined to the plateau top and the south-facing slopes of the mesa; both these sites are likely to have most favourable moisture balances when compared with other sites in the study area.

38442 (2)

Species absent from the plateau top.

A number of species which were often found on the laterite of uplands in the Mt Lesueur area were not found on the lateritic plateau of Mt Lesueur itself. We therefore compared the species list for Mt Lesueur with that resulting from a survey of nearby lateritic uplands (our unpublished data) and another survey of lateritic uplands from Jurien to Three Springs (Griffin *et al.*, 1983). The results of this comparison are reported in colums L and M of Appendix I. Some 85% (242 species) of the total Mt Lesueur flora had been found on lateritic uplands in the Mt Lesueur-Cockleshell Gully area. Of these, 109 species occurred on the slopes but not in the seemingly equivalent lateritic habitat on the top of Mt

Table 3.

Species at the limit of geographic range or with apparently disjunct distributions.

Species	Nearest Collections
Acacia obovata	Perth Metropolitan Area
Acacia teretifolia	Perth M.A.
Anarthria gracilis	Hill River
Astroloma ciliatum	Gingin
Billardiera coeruleo-punctata	Perth M.A.
Boronia crassifolia	Tutanning Nature Reserve
Chorizema ilicifolium	Regans Ford
Eucalyptus calophylla	Northern limit
Eucalyptus marginata	Northern limit
*Eucalyptus wandoo**	Northern limit
Gastrolobium ilicifolium	Mogumber
Grevillea synapheae	Northern limit
Hakea auriculata var. *sphathulata*	Northern limit
Hakea marginata	New Norcia
Hibbertia montana	Bindoon
Isopogon asper	Cataby
Isopogon sphaerocephalus	Perth M.A.
Kingia australis	Northern limit
Lasiopetalum floribundum	Perth M.A.
Lepidosperma viscidum	Wheatbelt
Patersonia sericea var. *rudis*	Wannamal
Prasophyllum parvifolium	Northern limit
Pultenaea ericifolia	Perth M.A.
Stylidium carnosum	Perth M.A.
Stylidium pychnostachyum	Perth M.A.
Thysanotus anceps	Perth M.A.

* One further species, *Eucalyptus haematoxylon*, has recently been collected nearby. This species is generally confined to the wetter, forested region well to the south.

Lesueur. These included *Amphipogon strictus, Caustis dioica, Daviesia decurrens, D. pedunculata, D. preissii, Hakea auriculata, H. stenocarpa, Pileanthus filifolius* and *Synaphea polymorpha*. A number of other species that were characteristic of lateritic uplands in the area were very poorly represented on the top of Mt Lesueur. For example, we found only a few individuals of each of *Allocasuarina humilis* and *Ereunaea violaceae* on the plateau.

The Vegetation of the Plateau top and rim

The vegetation of the upland area of Mt Lesueur is composed of three distinct strata, of which only the third (and lowest) was continuous over the plateau top:

(i) A tall shrub stratum composed principally of *Banksia tricuspis* to 3.5 m tall with occasional *Nuytsia floribunda* (to 4 m). Formations with tall shrubs present (high shrublands to high open-shrublands) covered about 25% of the surface of the plateau.

(ii) A shrub stratum (1-2 m tall) was present over about 30% of the surface. This stratum was dominated by *Dryandra sessilis* with occasional *Hakea trifurcata* and *H. undulata*, but mallee-form *Eucalyptus marginata, E. sp.* (EAG 2575) and *E.* sp. (S. D. Hopper 2231) also occurred in patches on the more gravelly soils of the north-east. *Dryandra sessilis* dominated formations (open to closed heath) were most common in areas where the surface was rough, with abundant broken duricrust present. These situations were most prevalent on the northern and north-western portions of the plateau and around much of the rim.

(iii) A low shrub stratum (< 1 m tall) was the most important and abundant stratum: it occurred under all other strata and was of diminished importance only where *D. sessilis* formed a closed-heath. The relatively closed low shrub canopy was rather uneven in height, ranging from 30 to 90 cm tall. This stratum was rich in angiosperm species, particularly woody perennial shrub species, but with a number of sedges and restiads (e.g. *Mesomelaena tetragona, Restio sphacelatus, Tetraria octandra)* and geophytes (e.g. *Drosera macrantha, Elythranthera brunonis, Thysanotus thyrsoideus)* present. Only one therophyte species *(Hypochoeris glabra)* was located on the top, but a further three species *(Danthonia caespitosa, Trachymene pilosa, Waitsia paniculata)* were common in the cracks of the rim zone. The larger of the low shrubs were usually 50-90 cm tall but occasionally exceeded 1 m. Larger shrub species included *Calothamnus sanguineus, Daviesia* sp. *aff striata* (EAG 1822), *D. longifolia, Dryandra armata, Hakea megalosperma* and *Lambertia multiflora*. The *arborescent* monocots, *Kingia australis* and *Xanthorrhoea reflexa*, were conspicuous in this low shrub layer, frequently emerged from it and reached 1.5 m in height. Amongst the more abundant low shrubs and herbs (20-25 cm tall) were *Actinostrobus acuminatus, Astroloma* sp. (EAG 1022), *Banksia micrantha, Conothamnus trinervis, Darwinia helichrysoides, Dryandra nivea, Grevillea synapheae, Hakea conchifolia, H. incrassata, Hibbertia acerosa, Hypocalymma xanthopetalum, Isopogon asper, Lysinema ciliatum, Macropidia fuliginosa, Melaleuca* sp. aff. *megacephala* (EAG 2359), *Petrophile striata, Sphaerolobium macranthum* and *Synaphea petiolaris*. Few species dominated the cover of this low shrub stratum with only *Banksia micrantha, Calothamnus sanguineus, Dryandra armata, Lambertia multiflora* and *Petrophile striata* exceeding 5% within quadrats.

In the occasional small pockets of sand, each of which may occupy up to 0.1 ha, species more common on sandy soils, rather than laterite, were found (e.g. *Adenanthos cygnorum, Bossiaea eriocarpa, Hakea ruscifolia* and *Lomandra hastilis)*.

The vegetation of the slopes

The tall shrub species which were prominent on the plateau top *(Banksia tricuspis* and *Dryandra sessilis)* were much less abundant on the slopes but, apart from this feature the slope vegetation was similar in appearance to that of the plateau. *B. tri-*

cuspis occurred occasionally on the western and southern slopes, mainly at middle to high elevations. *Dryandra sessilis* was abundant in only a few places, mainly on the northern and eastern slopes within 20 m of the top. Dense clumps of multi-stemmed *Eucalyptus marginata* (less than 2 m tall but up to 15 m crown diameter) were common on the southern slopes. *Xanthorrhoea reflexa* was generally less than 1 m tall on the slopes and therefore not visually dominant whereas *Kingia australia* was commonly >1 m tall and therefore more conspicuous. *Kingia* up to 2.5 m tall were present at the base of the northern slopes.

At the base of the southern, western and northern slopes on sandy soils, *Banksia attenuata* and *Eucalyptus todtiana* formed high shrublands and low open-woodlands. This vegetation formation was typical of the sandy valleys of this area. The vegetation of the eastern (and steepest) slopes changed in response to change in soil types. In the heavier soils of the lower slopes there were small patches of low woodland to low open-woodland with *Eucalyptus calophylla, E. marginata, E. wandoo* and *E. accedens.*

The shrub stratum of the slopes varied in structure from very sparse low open-shrublands on the steeper parts of the eastern slopes to low open-heath on the northern slopes, low open and low closed heath on the southern and western slopes and open and closed heath on part of the eastern slopes. Many of the major shrub species of the plateau were also abundant on the slopes. A notable absence was *Hakea megalosperma* (the Lesueur Hakea). *Banksia micrantha* was much less abundant on the slopes. However the slopes supported a great number of species which were either absent from, or rare on, the plateau. For example, *Hakea neurophylla* was abundant on the higher north-eastern slopes, *Allocasuarina humilis, Daviesia decurrens, Eremaea violacea, Leucopogon plumiflorus* and *Melaleuca tricrophylla* were abundant on the southern, western and northern slopes, and *Gastrolobium spinosum* and *Petrophile chrysantha* were abundant on the lower eastern slopes, but all were poorly represented on the plateau top. *Cryptandra arbutiflora, Hakea auriculata* var. *auriculata, Labichea punctuata, Neurachne alopecuroidea, Petrophile chrysantha* and *Pultenaea ericifolia* were prominent on the slopes but we did not locate any individuals on the plateau top.

Discussion

We have recorded 287 vascular plant species growing on Mt Lesueur. The study site is small, being less than 0.5 km^2, yet it includes a variety of habitat types. Kwongan, which is the predominant vegetation of the site, is generally regarded as a floristically rich vegetation type when compared with other types around the world (George *et al.* 1979, Lamont *et al.* 1984). But Mt Lesueur seems to be exceptional. By comparison, for example, 429 species were recorded for a site about 100 km north, but that site encompassed an area of 20 km^2 and included six units of vegetation that could be distinguished on air photos (Hopkins and Hnatiuk 1981). At Tutanning Nature Reserve, 350 km south-east of Mt Lesueur, 11 discrete patches of kwongan on 4 distinct soil types totalling 0.6 km^2 but dispersed throughout the 20 km^2 reserve contained 315 species (Brown and Hopkins 1983).

For almost 25% of the species encountered on Mt Lesueur, the locality is of special significance. Some species (the restricted relicts and those with disjunct distributions) have persisted there while populations at a distance have become extinct; another suite of species (the recently derived, restricted species) may have evolved around Mt Lesueur and not migrated to any extent. For the persistent species, the Mt Lesueur area is a refugium (cf. George *et al.* 1979, Hopkins *et al.* 1983). The evidence suggests that climatic factors/moisture balance are more favourable in this area than in adjacent areas since the general soil types of the mesa are widely distributed elsewhere in south-western Australia (Northcote *et al.* 1967, Churchward 1970, Mulcahy 1973, Lowry 1974). Further, many of the species now showing disjunctions in distribution are likely to have had continuous distributions to Mt Lesueur in the wet, early Holocene (Lange 1960, Churchill 1968, Hopkins *et al.* 1983).

At least some of these persistent species are confined to sites of probable, most favourable moisture relations on the mesa: the S-facing slope and the plateau top. Included are both relict species (e.g. *Hakea megalosperma)* and species with major distribution disjunctions (e.g. *Eucalyptus marginata).* We interpret these local distribution patterns and, in some cases, growth habits, (e.g. mallee *Eucalyptus marginata;* to the south this species develops as single stemmed trees to *c.* 40 m tall) to indicate the species are close to their environmental limits under present climatic conditions. We suggest that even slightly more arid conditions, say a 10-15% long-term decrease in annual rainfall, could cause extinctions of Mt Lesueur populations (see Hnatiuk and Hopkins 1980 for an account of effects of drought on kwongan). For the restricted relict species this would mean total extinction. For the disjunct species, recolonization from the south would probably be contingent upon a return of climatic conditions similar to those of the early Holocene.

This contention, if correct, implies that the climate of south-western Australia has not been substantially more arid than it now is, at least through the Holocene and perhaps since a much earlier time. Bowler (1981) derived a similar conclusion from a study of salt lakes in south-eastern Australia. Lundelius (1960), who examined cave faunal deposits from a site near to Mt Lesueur, asserted that the present climate was the result of gradual drying since the early Holocene. While there is now resonable evidence of mid to late Holocene climate fluctuations (e.g. Churchill 1968, Bowler 1981, Singh 1981) the severity of the arid phases as encapsulated in the concept of a "Great Australian Arid Period" (Crocker and Wood 1947) seems inconsistent with our observations.

A large number of typical lateritic upland species was either totally absent from, or represented by only one or two individuals on, the plateau top of Mt Lesueur. Many of these occurred on the slopes and some were abundant on the rim within 5 m of the plateau edge. Whilst this demonstrates that few species appear to show a distinct and consistent preference for laterite as a soil type, a number of other points may be made about these anomalous absences:

(i) they may indicate that the laterite of Mt Lesueur is different from that of nearby lateritic areas. The sedimentary rock type from which the lateritic soil profile of the mesa developed is well represented on other lateritic uplands nearby, so this explanation seems unlikely.

(ii) they merely reflect the extreme heterogeneity of the species-rich kwongan vegetation. The low homotoneity, of high beta diversity, of this vegetation and some possible factors contributing to it have been discussed by Griffin *et al.* (1983), and Hopkins and Griffin (1984).

(iii) some species may have become extinct on Mt Lesucur and, because of the nature of the site and the generally low vagility of propagules of many of the species *(cf.* Clifford and Drake 1981) there has been no recolonization. Some of the missing species are obligate seed regenerators with seed storage in the foliage in bradyspores): these species are particularly sensitive to disturbances such as recurrent fire (Gill and Groves 1981, Griffin and Hopkins 1981, Hopkins and Griffin 1984). However, the absent species include a number of resprouters, as well as species which are present on the rim of the plateau.

(iv) some typical latcrite species may have been precluded from successfully colonizing the plateau top of Mt Lesueur by the presence of species for which the site is a refugium. Niche pre-emption or competitive exclusion hypotheses could be evoked to explain the mechanism of preclusion but we have no data to test such hypotheses. However, we note that thc plateau top has probably provided a very stable habitat for plant species throughout the Quaternary whereas the slopes that are constantly eroding and producing gaps of bare ground do support many of these typical laterite species. Irrespective of the mechanism, the concept implies that the top of Mt Lesueur may be close to a maximum of species-richness for this habitat type.

We have attempted to reconcile our list of plant species from Mt Lesueur with that given by Speck (1958) for the top of the mesa. Twenty-four of his species were not located on the plateau top or rim area during the present survey but half of these did occur on the slopes while the others were found on a variety of soils in the general Mt Lesueur-Cockleshell Gully region. It is difficult to believe that as many as 24 species have become extinct on the top of Mt Lesueur in the past 25 years. Rather we believe that Speck's concept of the top was more general than the one we have used. However, given the thorough nature of our survey it will be possible for future workers to study immigration and extinction rates. It is relevant to note that only three introduced species, *Hypochoeris glabra, Pentaschistis airoides* and *Ursinia anthemoides*, were found on Mt Lesueur during this study; the last two of these occurred in sheltered sites amongst the lateritic rubble of the plateau rim.

A variety of structural vegetation types has been described for the plateau and the slopes of Mt Lesueur, all of which consist predominantly of sclerophyllous, perennial shrub species. The distribution of the structural types is strongly influenced by the distribution of a few tall species; in some cases these dominants actually indicate important ecological features but this need not be the case *(cf.* Hnatiuk and Hopkins 1981). The most important component of the vegetation is the low shrub stratum which is rich in species and complex in pattern. This stratum may be overlooked in the Specht (1970) vegetation classification which is based on the physiognomic dominants. However, with the Beard and Webb (1974) scheme, vegetation is classified by the stratum contributing the most biomass. The vegetation is correctly described by the latter schcme as heath (Beard 1979). The general term kwongan (Beard 1976) also adequately describes this physiognomicaly hcterogeneous vegetation.

Conservation

Mt Lesueur is a place of historical interest and botanical importance. In this paper we have described in detail the botanical values of the mesa and discussed the likely significance of some of them. Results of our studies have confirmed the pressing need for the area to be given adequatc conservation status as previously recommended. But rcservation alone is not sufficient: appropriate management, particularly in relation to fire, is also of critical importance for the long-term maintenance of the biological values of the area. We note the announcement by Government, in May 1983, of its intention to creatc a large Nature Reserve in the area of Mt Lesueur. We urge that this be implemented expeditiously and that a management programme be established as soon as practicable.

Acknowledgments.—The work reported here was wholly funded by the Western Australian Department of Fisheries and Wildlife. Mr. Ken Fitzgerald of Cantabilling Spring kindly provided accommodation during the field programme. We thank Dr. R. J. Hnatiuk for helpful comments throughout the study and the two reviewers for their constructive suggestions on an earlier draft of the paper.

References

Aplin, T. E. H. (1979).—Flora. In *Environment and Science*, ed. B. J. O'Brien, pp. 53-76, Univ. West. Aust. Press, Perth.

Beard, J. S. (1976).—An indigenous term for the Western Australian sandplain and its vegetation. *J. Roy. Soc. West. Aust.*, 59: 55-57.

Beard, J. S. (1979).—Vegetation survey of Western Australia. The Vegetation of the Moora and Hill River Areas, Western Australia. Map and Explanatory Memoir. 1:250 000 Series. Vegmap Publications, Perth.

Beard, J. S. (1980).—A new phytogeographic map of Western Australia. *West. Aust. Herb. Res. Notes* 3: 37-58.

Beard, J. S. and Webb, M. J. (1974).—The vegetation survey of Western Australia: Its aims, objects and methods. In *Vegetation Survey of Western Australia. Explanatory Notes to Sheet 2*, pp. 1-17, Univ. West. Aust. Press, Perth.

Bowler, J. M. (1981).—Australian salt lakes. A palaeohydrologic approach. *Hydrobiologia*, 82: 431-444.

Brown, J. M. and Hopkins, A. J. M. (1983).—The kwongan (sclerophyllous shrubland) of Tutanning Nature Reserve, Western Australia. *Aust. J. Ecol.*, 8: 63-73.

Bureau of Meteorology (1968).—Climatic Survey. Region 14 —Midlands, Western Australia. Issued by the Director of Meteorology, Melbourne.

Churchill, D. M. (1968).—The distribution and prehistory of *Eucalyptus diversicolor* F. Muell., *E. marginata* Donn ex Sm., and *E. calophylla* R. Br. in relation to rainfall. *Aust. J. Bot.*, 16: 125-51.

Churchward, H. M. (1970).—Erosional modification of a lateritized landscape over sedimentary rocks. Its effect on soil distribution. *Aust. J. Soil Res.*, 8: 1-19.

Clifford, H. T. and Drake W. E. (1981).—Pollination and dispersal in eastern Australian heathlands. In *Ecosystems of the World*. Vol. 9B. *Heathlands and Related Shrublands Analytical Studies*, ed. R. L. Specht, pp. 39-49, Elsevier Amsterdam.

Crocker, R. L. and Wood, J. G. (1947).—Some historical influences on the development of the South Australian vegetation communities and their bearing on concept and classification in ecology. *Trans. Roy. Soc. S. Aust.*, 71: 91-136.

CTRC (1975).—Conservation Reserves in Western Australia. Report of the Conservation Through Reserves Committee to the Environmental Protection Authority 1974. Dept. Cons. Envt., Perth.

Gardner, C. A. (1947).—The botany of the Hill River District. *West. Aust. Nat.*, 1: 1-6.

George, A. S., Hopkins, A. J. M. and Marchant N. G. (1979).—The heathlands of Western Australia. In *Ecosystems of the World*. Vol. 9A. *Heathlands and Related Shrublands. Descriptive Studies*, ed. R. L. Specht, pp. 211-30, Elsevier, Amsterdam.

Gill, A. M. and Groves, R. H. (1981).—Fire regimes and their plant ecological effects. In *Ecosystems of the World*. Vol. 9B *Heathlands and Related Shrublands. Analytical Studies*, ed. R. L. Specht, pp. 61-84, Elsevier, Amsterdam.

Griffin, E. A. and Hopkins. A. J. M. (1981).—The short term effect of brush harvesting on the kwongan vegetation at Eneabba, Western Australia. *Dept. Fish. Wildl. West. Aust. Rept. No.* 45: 1-38.

Griffin, E. A., Hopkins, A. J. M. and Hnatiuk, R. J. (1983).—Regional variation in Mediterranean-type shrublands at Eneabba, south-western Australia. *Vegetatio*: 52: 103-127.

Hnatiuk, R. J. and Hopkins, A. J. M. (1980).—Western Australian species-rich kwongan (sclerophyllous shrubland) affected by drought. *Aust. J. Bot.*, 28: 573-85.

Hnatiuk, R. J. and Hopkins, A. J. M. (1981).—An ecological analysis of kwongan vegetation south of Eneabba, Western Australia. *Aust. J. Ecol.*, 6: 423-438.

Hopkins, A. J. M. and Griffin, E. A. (1984).— Floristic patterns. In *Kwongan—Plant Life of the Sandplain*, eds. J. S. Pate and J. S. Beard, pp. 69-83, Univ. West. Aust. Press, Perth.

Hopkins, A. J. M. and Hnatiuk, R. J. (1981).—An ecological survey of the kwongan south of Eneabba, Western Australia. *Wildl. Res. Bull. West. Aust.*, 9: 1-33.

Hopkins, A. J. M., Keighery, G. J. and Marchant, N. G. (1983).—Species-rich uplands of south-western Australia. *Proc. Ecol. Soc. Aust.*, 12: 15-25.

Hopper, S. D. (1983).—Rare flora of the Mount Lesueur area. *S.W.A.N.S.*, 13 (3): 14-16. West. Aust. Dept. Fish. Wildl., Perth.

Lamont, B. B., Hopkins, A. J. M. and Hnatiuk, R. J. (1984).—The flora—composition, diversity and origins. In *Kwongan—Plant Life of the Sandplain*, eds. J. S. Pate and J. S. Beard, pp. 27-50, Univ. West. Aust. Press, Perth.

Lange, R. T. (1960).—Rainfall and soil control of tree species distribution around Narrogin, Western Australia. *J. Roy. Soc. West. Aust.*, 60: 49-60.

Lissiman, J. C. and Oxenford, R. J. (1973).—The Allied Minerals NL Heavy Mineral Sands Deposit at Eneabba, Western Australia. *Proc. Aust. Inst. Min. Met.* Perth, May 1973 pp. 153-161.

Lowry, D. C. (1974).—Geological Survey of Western Australia. 1:250 000 Geological Series—Explanatory Notes. Dongara-Hill River, Western Australia (Sheet SH/50-5, 9). Aust. Govt. Publ. Serv., Canberra.

Lundelius, E. L. (1960).—Post Pleistocene faunal succession in Western Australia and its climatic interpretation. *Report. Int. Geol. Congress. 21st Session. Part IV*: 142-53.

Marchant, N. G. and Keighery, J. G. (1979).—Poorly collected and presumably rare vascular plants of Western Australia. *Kinks Park Res. Notes* 5: 1-103.

Mueller-Dombois, D. and Ellenberg, H. (1974).—*Aims and Methods of Vegetation Ecology*. Wiley, New York.

Mulcahy, M. J. (1973).—Landforms and soils of southwestern Australia. *J. Roy. Soc. West. Aust.*, 56: 16-22.

Northcote, K. H., Bettenay, E., Churchward, H. M. and MacArthur, W. M. (1967).—Atlas of Australian Soils.. Explanatory Data for Sheet 5. Perth-Albany-Esperance Area. Cambridge Univ. Press, London.

Playford, P. E., Cockbain, A. E., and Low G. H. (1976).—Geology of the Perth Basin, Western Australia. *Geol. Surv. West. Aust. Bull.*, 124: 1-311.

Roy, G. G. and Miller, S. G. (1980).—Data handbook for Australian solar energy designers. Univ. West. Aust. Sch. Arch. Research Rept. No. 7.

Rye, B. L. (1982).—Geographically restricted plants of Southern Western Australia. *Dept. Fish. Wildl. West. Aust. Rept. No.* 49: 1-63.

Rye, B. L., and Hopper, S. D. (1981).—A guide to the gazetted rare flora of Western Australia. *Dept. Fish. Wildl. West. Aust. Rept. No.* 42: 1-211.

Singh, G. (1981).—Late Quaternary pollen records and seasonal palaeoclimate of Lake Frome, South Australia. *Hydrobiologia*, 32: 419-430.

Specht, R. L. (1970).—Vegetation. In *The Australian Environment*, 4th Edn, ed. G. W. Leeper, pp. 44-67, CSIRO and Melbourne Univ. Press, Melbourne.

Speck, N. H. (1958).—The vegetation of the Darling-Irwin Botanical Districts and an investigation of the distribution of the family Proteaceae in south-western Australia. Unpublished Ph.D. thesis, Bot. Dep. Univ. Western Australia.

Thompson, J. (1976).—A revision of the genus *Tetratheca* (Tremandraceae). *Telopea* 1: 139-215.

UNESCO-FAO (1963).—Ecological study of the Mediterranean Zone. Bioclimatic map of the Mediterranean Zone. *Arid Zone Res.*, 21: 2-58.

Postscript. A severe wildfire was reported for the proposed reserve on 10-12 May 1985. At the time of going to press the effect of this fire on Mt Lesueur had not been assessed.

38442 (3)

Appendix I.

Species present on Mt. Lesueur on the plateau top, rim and along the 8 slope transects, together with some comparative data on species occurrences on other lateritic uplands in the Mt. Lesueur-Cockleshell Gully region (Griffin *et. al.* 1983, Griffin and Hopkins unpublished data). For species of uncertain identity, specimen collection numbers are given in brackets.

Species	Top			Slopes									
	A	B	C	D	E	F	G	H	1	J	K	L	M
Acacia alata	3				+		+	+				2	
Acacia auronitens				+	+	+	+					3	7
Acacia epacantha			+					+				2	
Acacia incrassata										+		0	
Acacia lasiocarpa var. *lasiocarpa*											+	3	7
Acacia obovata	1						+	+	+	+	+	1	
Acacia pulchella var. *glaberrima*		+						+				1	
Acacia retrorsa										+	+	0	
Acacia stenoptera										+		3	7
Acacia tamminensis						+	+					3	7
Acacia teretifolia				+	+	+	+	+		+	+	1	
Acacia sp. aff. *celastrifolia* (EAG 2219)	1						+	+				1	
Actinostrobus acuminatus	4			+	+	+	+	+	+	+	+	4	
Adenanthos cygnorum		+										0	
Allocasuarina grevilleoides										+		1	
Allocasuarina humilis		+		+	+	+	+	+	+	+	+	4	4
Allocasuarina microstachya						+						2	
Amphipogon strictus				+	+	+	+	+	+	+	+	4	8
Anarthria gracilis				+		+	+	+	+	+	+	3	7
Andersonia lehmanniana					+	+						3	7
Anigozanthos humilis					+	+	+		+			2	
Astroloma ciliatum										+	+	0	
Astroloma microdonta			+			+				+	+	3	5
Astroloma serratifolium				+			+		+	+	+	2	
Astroloma stomarrhena							+					2	
Astroloma sp. (EAG 1022)	5			+	+	+	+	+	+	+	+	4	
Baeckea crispiflora										+	+	0	
Baeckea grandiflora	5			+	+	+	+	+	+	+	+	4	
Banksia attenuata					+		+					0	
Banksia grossa							0					1	
Banksia micrantha	4			+			+	+	+			4	
Banksia tricaspis	3			+			+	+	+	+	+	2	
Billardiera bicolor											+	0	
Billardiera coeruleo-punctata		+								+		1	
Boronia crassifolia	2						+	+	+	+		1	
Boronia ramosa	2											2	
Borya nitida										+	+	1	
Bossiaea eriocarpa		+										1	
Burchardia umbellata	2			+	+	+	+	+	+	+	+	4	
Caladenia patersonii			+									0	
Calandrinia sp. indet.			+									0	
Calectasia cyanea	2			+	+	+	+	+	+	+	+	4	
Calothamnus quadrifidus				+	+					+	+	2	
Calothamnus sanguineus	5			+	+	+	+	+	+	+	+	4	
Calothamnus torulosus	3			+	+	+	+	+	+	+	+	4	
Calytrix flavescens				+	+	+				+	+	2	
Cassytha glabella	1			+	+	+	+	+	+	+		4	2
Cassytha pomiformis	5			+	+	+	+	+	+	+	+	4	
Caustis dioica				+								4	8
Centrolepis drummondii			+									1	
Chamaescilla corymbosa								+	+	+		1	
Chorizema ilicifolium											+	0	
Comesperma acerosum		+		+		+	+	+	+	+	+	4	4
Comesperma volubile						+				+	+	1	
Conospermum uervosum	2			+						+	+	2	
Conospermum triplinervium					+	+	+		+		+	1	
Conostephium pendulum	2						+		+			1	
Conostylis aculeata			+		+							0	
Conostylis androstemma		+		+	+	+	+	+		+	+	4	4
Conostylis aurea					+	+			+			3	7
Conostylis crassinervia	5			+	+	+	+	+	+	+	+	3	
Conostylis teretifolia					+	+	+	+	+			3	7
Conostylis teretiascula				+								3	7
Conothamnus trinervis	5			+	+	+	+	+	+	+	+	4	
Crassala ? colorata			+									1	
Cryptandra arbatiflora				+	+	+	+	+	+	+	+	4	8
Cryptandra leucophracta				+		+	+	+	+		+	2	
Cryptandra pungens		+		+	+	+				+	+	3	3
Dampiera lavendulacea										+		0	
Dampiera lindleyi		+				+			+			2	
Dampiera spicigera						+	+			+	+	2	
Danthonia caespitosa			+									1	
Darwinia helichrysoides	5			+	+	+	+	+	+	+	+	3	
Darwinia neildiana										+	+	2	
Darwinia sanguinea							+	+	+			3	7
Dasypogon bromeliifolius					+	+	+	+	+			0	
Daviesia decurrens			+		+	+	+	+	+	+	+	4	6
Daviesia incrassata											+	0	
Daviseia jancea					+		+		+			0	
Daviesia lougifolia	4				+	+	+	+	+	+	+	1	
Daviesia pedunculata				+	+		+	+	+	+		4	8
Daviesia preissii				+	+	+	+	+	+	+		4	8
Daviesia sp. aff. *striata* (EAG 1822)	5			+	+	+	+			+	+	3	

Species	Top			Slopes									
	A	B	C	D	E	F	G	H	I	J	K	L	M
Dianella revoluta	....	....	....	....	....	....	....	....	....	....	+	0	....
Diplolaena ferruginea	....	....	+	....	+	+	+	+	....	+	+	1	....
Diplopeltis huegelii	....	....	....	....	....	....	+	....	....	....	....	1	....
Dodonaea ericoides	....	....	....	+	....	....	....	....	....	+	+	2	....
Drosera erythrorrhiza	1	....	....	....	....	....	+	+	+	+	+	4	2
Drosera heterophylla	....	....	....	....	....	....	....	....	0	....	....	3	7
Drosera leucoblasta	4	....	....	....	....	+	....	....	....	....	....	1	....
Drosera macrantha	5	....	....	+	+	+	+	+	+	+	+	4	....
Drosera stolonifera	1	....	....	+	....	....	+	+	....	....	....	4	2
Dryandra armata	5	....	....	+	+	+	+	+	+	+	+	4	....
Dryandra bipinnatifida	5	....	....	+	+	+	+	+	+	+	....	4	....
Dryandra nivea	5	....	....	+	+	+	+	+	+	+	+	4	....
Dryandra sclerophylla	4	....	....	+	....	....	+	....	....	....	....	4	....
Dryandra sessilis	5	....	....	+	+	+	....	....	....	+	....	2	....
Elythranthera brunonis	5	....	....	....	....	....	....	+	....	+	+	4	....
Eremaea acutifolia	....	....	....	....	....	....	+	....	....	....	....	1	....
Eremaea violacea	....	+	....	+	+	+	+	....	+	+	+	3	3
Eremaea sp. (EAG)	....	....	....	+	....	....	+	....	+	....	....	1	....
Eriostemon spicatus	5	....	....	+	+	+	+	+	+	+	+	4	....
Eucalyptus accedens	....	....	....	+	....	....	....	....	....	+	+	0	....
Eucalyptus calophylla	....	....	....	....	....	....	....	....	....	0	....	0	....
Eucalyptus drummondii	....	....	....	....	....	....	....	....	....	+	....	1	....
Eucalyptus gittinsii	....	....	....	....	....	+	....	....	....	....	....	1	....
Eucalyptus marginata	....	+	....	....	....	....	....	+	+	+	+	1	....
Eucalyptus todtiana	....	....	....	+	....	+	+	....	....	....	....	0	....
Eucalyptus wandoo	....	....	....	....	....	....	....	....	....	0	....	0	....
Eucalyptus sp. (*suberea*) (EAG 2575)	....	+	....	....	....	....	....	....	....	....	+	1	....
Eucalyptus sp. (S. D. Hopper 2231)	....	+	....	....	....	....	....	....	....	....	....	1	....
Gastrolobium bidens	....	+	....	+	+	+	+	+	+	+	....	4	4
Gastrolobium ilicifolium	....	....	+	+	....	....	....	....	+	+	+	1	....
Gastrolobium oxylobioides	....	....	....	....	+	....	+	....	....	+	+	1	....
Gastrolobium pauciflorum	....	....	+	....	....	....	....	....	....	....	....	2	....
Gastrolobium spinosum	....	....	....	....	....	....	....	....	....	+	+	2	....
Glischrocaryon aureum	....	....	....	....	....	....	....	....	....	+	+	2	....
Gompholobium aristatum	....	....	....	....	+	....	....	....	....	....	....	0	....
Gompholobium knightianum	4	....	....	+	+	+	+	+	+	+	+	3	....
Gompholobium preissii	5	....	....	+	+	+	+	+	+	....	....	3	....
Gompholobium sp. (EAG 2306)	....	....	+	+	....	+	....	+	+	+	+	1	....
Goodenia caerulea	1	....	....	+	....	+	+	+	+	+	+	4	2
Goodenia filiformis	....	....	....	....	....	....	....	....	....	....	+	0	....
Goodenia hassallii	....	....	....	+	....	....	....	....	....	....	+	1	....
Grevillea synapheae	5	....	....	+	+	+	+	+	+	+	....	4	....
Haemodorum sp. indet (EAG 1616)	....	....	....	+	....	+	....	....	....	+	+	3	7
Haemodorum sp. (EAG 1296)	....	....	....	....	+	....	....	....	....	....	....	1	....
Haemodorum sp. (EAG 1564)	5	....	....	+	+	+	+	+	+	+	+	4	....
Hakea auriculata var. *auriculata*	....	....	....	+	+	+	....	....	....	....	+	4	8
Hakea auriculata var. *spathulata*	....	....	....	+	....	....	....	....	....	+	+	3	7
Hakea conchifolia	5	....	....	+	+	+	+	+	+	+	....	4	....
Hakea costata	....	....	....	....	....	....	+	....	+	....	....	0	....
Hakea erinacea (form)	....	....	....	+	+	+	....	+	....	+	+	1	....
Hakea flabellifolia	....	+	....	....	+	....	+	....	....	....	....	2	....
Hakea incrassata	5	....	....	+	+	+	+	+	+	+	+	4	....
Hakea lissocarpha	1	....	....	+	+	+	+	+	....	+	+	4	2
Hakea marginata	....	....	....	....	....	....	....	....	....	+	....	0	....
Hakea megalosperma	2	....	....	....	....	....	....	....	....	....	....	2	....
Hakea neurophylla	....	....	+	+	....	+	....	....	....	+	+	2	....
Hakea ruscifolia	....	+	....	....	+	+	+	+	+	....	....	1	....
Hakea stenocarpa	....	....	....	....	+	+	....	....	....	+	....	4	8
Hakea trifurcata	1	....	....	....	....	....	+	....	....	....	....	3	1
Hakea undulata	....	....	+	....	....	+	+	....	....	+	+	2	....
Heuigenia curvifolia	....	....	....	....	....	....	....	....	....	+	+	1	....
Hibbertia acerosa	5	....	....	+	+	+	+	+	+	+	+	4	....
Hibbertia aurea	5	....	....	+	+	+	+	+	+	+	+	4	....
Hibbertia huegelii	4	....	....	+	+	+	+	....	+	....	+	4	....
Hibbertia ? hypericoides	4	....	....	+	+	+	+	+	+	+	+	4	....
Hibbertia montana	....	....	....	....	+	....	....	+	....	....	....	0	....
Hibbertia pachyrrhiza	....	....	....	....	....	....	....	....	....	....	+	1	....
Hibbertia sp. (EAG 2711)	4	....	....	+	+	+	+	+	+	+	+	4	....
Hovea stricta	5	....	....	+	+	+	+	+	+	+	....	4	....
Hovea trisperma	3	....	....	....	....	....	....	+	+	....	....	2	....
Hybanthus floribundus	....	....	+	....	....	....	....	....	....	....	....	2	....
Hypocalymma xanthopetalum	5	....	....	+	+	+	+	+	+	+	+	4	....
Hypochoeris glabra	4	....	....	....	....	....	....	....	....	....	....	3	....
Isopogon asper	5	....	....	+	+	+	+	....	+	+	....	4	....
Isopogon divergens	....	....	+	....	....	....	....	....	....	....	....	1	....
Isopogon linearis	5	....	....	....	....	+	+	+	+	+	....	4	....
Isopogon sphaerocephalus	5	....	....	+	....	+	+	+	+	+	+	2	....
Isotropis cuneifolia	....	....	....	....	+	....	....	....	....	....	....	0	....
Jacksonia floribunda	....	....	....	....	+	....	+	....	+	....	....	0	....
Jacksonia restioides	....	....	....	+	....	+	....	....	....	+	....	3	7
Kingia australis	5	....	....	+	+	+	+	+	+	+	+	4	....
Labichea punctata	....	....	....	+	+	....	+	+	....	+	....	4	8
Lambertia multiflora	5	....	....	+	+	+	+	+	+	+	+	4	....
Lasiopetalum floribundum	....	....	+	....	+	....	+	+	....	+	+	0	....
Laxmannia squarrosa	....	+	....	+	....	....	+	+	+	....	....	2	....
Lechenaultia biloba	....	....	+	....	....	....	....	....	....	....	+	4	6

Species	Top			Slopes									
	A	B	C	D	E	F	G	H	I	J	K	L	M
Lepidobolus chaetocephalus	....	....	....	+	+	....	....	....	....	+	....	2	....
Lepidobolus sp. (EAG 2093)	....	....	....	+	....	+	....	....	....	+	+	2	....
Lepidosperma angustatum	5	....	....	+	+	+	+	+	+	....	....	4	....
Lepidosperma striatum	....	....	....	....	....	+	+	....	....	....	+	1	....
Lepidosperma tenue	1	....	....	+	+	+	+	+	+	+	+	4	2
Lepidosperma viscidum	....	....	....	....	....	....	....	....	....	+	+	0	....
Leptomeria empetriformis	4	....	....	+	....	+	....	....	+	....	....	4	....
Leptospermum spinescens	1	....	....	+	....	....	+	....	....	....	....	4	2
Lepyrodia sp. (EAG 2535)	....	....	....	....	....	....	....	....	....	....	+	1	....
Leucopogon plumuliflorus	2	....	....	+	+	+	+	+	+	+	+	1	....
Leucopogon sp. (EAG 1031)	4	....	....	+	+	+	+	+	+	+	+	3	....
Leucopogon sp. (EAG 1645)	2	....	....	....	....	....	....	....	....	....	+	4	....
Levenhookia dubia	....	....	....	....	....	+	....	....	....	....	+	2	....
Logania spermacocea	1	....	....	+	....	....	+	+	+	+	+	3	1
Lomandra cuespitosa	4	....	....	....	+	+	....	....	....	+	+	3	....
Lomandra hastilis	....	+	....	....	....	....	....	....	....	....	....	0	....
Lomandru preissii	3	....	....	+	+	....	+	+	+	+	+	4	....
Lomandra sericea	5	....	....	+	+	+	+	+	+	+	+	4	....
Loxocarya cinerea	5	....	....	+	+	+	+	+	+	+	+	4	....
Loxocarya fasciculata	5	....	....	+	....	....	+	+	+	....	....	4	....
Lyginia barbata	....	....	....	....	....	....	+	+	....	....	....	0	....
Lysinema ciliatum	5	....	....	+	+	+	+	+	+	+	+	4	....
Macropidia fuliginosa	5	....	....	+	+	+	+	+	+	+	+	3	....
Macrozamia reidlei	....	....	....	....	....	....	....	....	....	0	....	0	....
Melaleucu acerosa	....	....	+	....	....	....	....	....	....	....	....	3	3
Melaleuca radula	....	....	....	....	....	....	....	....	....	+	+	1	....
Melaleucu ? scabra	....	....	....	....	+	+	+	....	+	+	+	3	7
Melaleuca trichophylla	....	+	....	+	+	+	+	+	....	+	+	4	4
Meluleuca sp. aff. *megacephala* (EAG 2359)	4	....	....	+	+	+	+	+	+	+	+	4	....
Melaleuca ? hybrids	....	+	....	....	....	....	....	....	....	....	....	2	....
Mesomeluena stygia	1	....	....	+	+	+	+	....	+	....	+	4	2
Mesomeluena tetragona	4	....	....	+	+	+	+	+	+	+	+	4	....
Mesomelaena sp. (EAG 1842)	5	....	....	+	....	+	+	+	+	+	....	3	....
Neurachne alopecuroidea	....	....	....	+	+	+	....	....	+	+	....	3	7
Nuytsia floribunda	....	+	....	....	....	+	....	+	+	....	....	2	....
Olax benthamianu	....	....	....	....	....	....	+	....	....	....	....	1	....
Olux sp. aff. *phyllanthi* (RJH 771499)	5	....	....	+	+	+	+	....	+	+	+	4	....
Opercularia spermacocea	....	....	....	....	+	....	....	....	+	+	....	4	8
Oxylobium capitatum	....	....	....	....	....	....	....	....	....	....	+	0	....
Oxylobium reticulatum var. *gracile*	....	....	....	+	....	....	....	....	....	....	....	3	7
Purietaria debilis	....	....	+	....	....	....	....	....	....	....	....	0	....
Patersonia drummondii	4	....	....	....	+	....	....	....	....	....	....	3	....
Patersonia occidentulis	5	....	....	+	+	+	+	+	+	....	+	4	....
Patersoniu sericea var. *rudis*	....	....	....	+	....	+	+	....	....	+	+	3	7
Pentaschistis airoides	....	....	+	....	....	....	....	....	....	....	....	1	....
Persooniu ucicularis	....	....	....	....	+	....	....	....	....	....	....	0	....
Persoonia conuta	1	....	....	....	....	....	....	....	....	....	....	2	....
Persoonia rudis	....	+	....	+	....	+	....	....	....	+	....	3	3
Persoonia sp. aff. *sulcuta* (EAG 795)	....	....	....	+	+	....	+	+	....	+	+	3	7
Petrophile chrysantha	....	....	....	+	+	+	....	....	....	+	+	2	....
Petrophile inconspicua	....	....	....	+	+	+	+	+	+	+	+	3	7
Petrophile linearis	....	....	....	....	....	....	....	....	+	....	....	1	....
Petrophile macrostachya	....	....	....	+	+	....	+	+	+	+	....	1	....
Petrophile brevifolia	2	....	....	+	+	+	+	+	+	+	....	4	....
Petrophile striata	5	....	....	+	+	+	+	+	+	+	+	4	....
Phlebocarya filifolia	....	....	....	....	....	....	+	+	+	+	....	1	....
Pileuntlus filifolius	....	....	....	....	+	....	+	....	....	....	....	3	7
Pimelea angustifolia	....	+	....	....	....	....	....	+	+	....	....	1	....
Pimelea imbricata	....	....	....	....	....	....	....	....	....	+	+	1	....
Pimelea sulphurea	1	....	....	+	+	+	+	+	+	+	+	4	2
Pithocarpa corymbulosa	5	....	....	+	+	+	+	+	+	+	+	4	....
Pityrodiu bartlingii	....	....	....	....	+	....	+	....	....	....	....	0	....
Platysace ? teres	....	....	....	+	+	....	+	+	....	+	....	3	7
Platysuce xerophila	4	....	....	....	....	....	+	+	....	....	....	3	....
Prasophyllum purvifolium	....	+	....	....	....	....	....	....	....	....	....	3	....
Prasophyllum sp. *indet*	1	....	....	+	....	+	....	....	....	+	....	3	1
Pterostylis nanu	....	....	....	....	....	....	....	....	....	....	+	1	....
Pultenaea ericifolia	....	....	....	+	....	+	+	+	+	+	....	0	....
Restio sphacelatus	1	....	....	+	+	+	+	+	+	....	....	4	2
Scaevola canescens	....	+	....	....	+	+	+	....	+	....	....	3	3
Scuevolu paludosa	5	....	....	+	+	+	+	+	+	+	....	4	....
Schoenus globifer	....	....	....	....	....	+	+	+	....	....	....	2	....
Schoenus subflavus	3	....	....	+	+	+	+	+	+	+	+	4	....
Schoenus unispiculatus	....	....	....	+	....	+	+	+	....	+	+	4	8
Schoenus sp. (EAG 1528)	....	+	+	+	+	+	+	+	+	+	+	4	4
Sehoenus sp. (EAG 2541)	1	....	....	....	....	....	....	....	....	....	....	1	....
Sphaerolobium macranthum	5	....	....	+	+	+	+	+	+	+	+	4	....
Spyridium tridentatum	....	....	+	+	+	....	....	....	+	....	....	1	....
Stackhousiu brunonis	1	....	....	+	....	+	+	+	....	....	+	3	1
Stirlingia latifoliu	....	....	....	....	+	+	+	....	....	....	....	0	....
Stylidium adpressum	....	....	....	....	+	+	+	+	+	....	+	3	7
Stylidium breviscupum	....	....	....	....	....	....	....	....	....	....	+	0	....
Stylidium carnosum	....	+	....	+	....	....	+	....	+	+	....	2	....
Stylidium diuroides	2	....	....	+	+	+	+	+	+	+	....	4	....

Species	Top			Slopes									
	A	B	C	D	E	F	G	H	I	J	K	L	M
Stylidium junceum	4	....	....	....	+	....	+	+	+	....	....	2	....
Stylidium leptocalyx	....	....	....	....	....	....	....	....	....	....	+	1	....
Stylidium piliferum	4	....	....	+	+	+	+	+	+	....	+	4	....
Stylidium pycnostachyum	....	....	....	+	....	+	....	+	....	+	+	2	....
Stylidium repens	1	....	....	....	....	....	....	....	....	....	....	2	....
Stylidium schoenoides	5	....	....	....	+	....	....	....	....	....	....	1	....
Synaphea petiolaris	5	....	....	+	+	+	+	+	+	+	+	3	....
Synaphea polymorpha	....	....	....	+	....	....	....	....	....	....	....	4	8
Templetonia biloba	....	....	....	+	+	+	....	....	....	....	....	2	....
Tetraria octandra	5	....	....	+	+	+	+	+	+	+	+	4	....
Tetratheca confertifolia	....	+	....	+	+	+	+	+	+	+	+	4	4
Tetratheca pauciflora	....	....	....	....	....	....	....	....	....	+	+	0	....
Thelymitra antennifera	....	....	....	....	....	+	....	....	....	....	....	0	....
Thelymitra villosa	1	....	....	....	....	....	....	....	+	....	+	2	....
Thomasia grandiflora	.. .	....	....	+	....	....	....	....	....	+	....	2	....
Thysanotus anceps	....	....	....	+	....	+	+	+	....	+	....	3	7
Thysanotus patersonii	4	....	....	+	+	+	+	+	+	+	+	4	....
Thysanotus sparteus	....	....	....	....	+	+	....	....	....	....	....	4	8
Thysanotus thyrsoideus	3	....	....	....	....	....	....	....	....	....	....	2	....
Thysanotus triandrus	2	....	....	....	....	....	+	+	+	....	....	3	....
Thysanotus sp. (EAG 2511)	....	....	....	....	+	....	....	....	....	+	+	3	7
Trachymene pilosa	....	....	+	....	....	....	....	....	....	....	....	1	....
Tricoryne elatior	....	....	+	....	+	+	+	+	+	+	....	4	6
Trymalium ledifolium	1	....	....	+	....	+	+	+	+	+	+	1	....
Urocarpus phebalioides	....	....	....	....	....	+	....	....	....	....	....	0	....
Ursinia anthemoides	....	....	+	....	....	....	....	....	....	....	....	1	....
Velleia trinervis	....	....	....	....	....	+	....	....	....	....	....	1	....
Verticordia chrysantha	....	....	....	....	....	....	....	....	....	+	....	2	....
Verticordia densiflora	....	....	....	....	....	....	....	....	....	....	+	3	7
Wahlenbergia gracilenta	....	....	+	....	....	....	....	....	....	....	....	0	....
Waitzia paniculata	....	....	+	....	....	....	....	....	....	....	....	1	....
Xanthorrhoea reflexa	5	....	....	+	+	+	+	+	+	+	+	4	....
Xanthosia huegelii	4	....	....	....	....	....	+	+	....	....	....	2	....
Xanthosia tomentosa	3	....	....	+	+	+	+	+	+	+	+	4	....

Column codings

A Number of quadrats on top in which species found (max = 5).

B For species not in A, + = presence on top > 5 m from edge.

C For species not in A or B, + = presence on rim < 5 m from edge.

D North-eastern transect (5 relevés) + = in relevé, 0 = nearby

E Northern transect (5 relevés) + = in relevé, 0 = nearby

F North-western transect (5 relevés) + = in relevé, 0 = nearby

G Western transect (5 relevés) + = in relevé, 0 = nearby

H South-western transect (4 relevés) + = in relevé, 0 = nearby)

I Southern transect (4 relevés) + = in relevé, 0 = nearby

J South-eastern transect (5 relevés) + = in relevé, 0 = nearby

K Eastern transect (5 relevés) + = in relevé, 0 = nearby

L Relative frequency of species occurrence on lateritic uplands in region (our unpublished data)
Code
0 — not found
1 — very low
2 — low
3 — medium
4 — high

M Coding of species which occur on lateritic uplands of the region and occur on the slopes of Mt Lesueur but are absent from or are infrequent occurrences on the top.
Code

8 — High frequency on uplands (Code 4 in column L) but absent from top,

7 — Medium frequency on uplands (3) but absent from top,

6 — High frequency on uplands (4) and only on rim of top,

5 — Medium frequency on uplands (3) and only on rim of top,

4 — High frequency on uplands (4) and occurring outside the quadrats on top.

3 — Medium frequency on uplands (3) and occurring outside of quadrats on top,

2 — High frequency on uplands (4) and occurring in only 1 quadrat on top.

1 — Medium frequency on uplands (3) and occurring in only 1 quadrat on top.

Other species uncoded.

38442 (4)